Ecological problems of the visual environment in settlements

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Abstract. The article deals with the problems of aggressiveness and homogeneity of the visual environment of settlements. The calculation of the coefficient of aggressiveness for the visual environment in the village of Maryanskaya along the streets of Severnaya and Shevchenko was carried out. The conclusion is made about the relevance of the problems under consideration for rural areas and cities.

1 Introduction

The constant growth of cities and the technosphere as a whole is increasingly leading to the isolation of society from nature. At the same time, the complete independence of society from the natural environment is impossible for many reasons. In addition to environmental pollution and, consequently, the deterioration of the conditions for the life of all organisms, as a result of the increasing influence of anthropogenic factors, the expansion of the technosphere leads to the emergence of other environmental problems specific to humans.

One such problem, which has only recently begun to be studied, is the problem of visual ecology. The main concept considered within the framework of this new scientific discipline, developed by the Russian scientist V. A. Filin, is the “visual environment”, that is, everything that is perceived by the human organs of vision [1]. It has been scientifically proven that the nature of the visual environment, its saturation with various elements or, conversely, the monotony, as well as the aesthetics of the surrounding landscape, have a direct impact on the psycho-emotional state of a person.

At the moment, the visual ecology of the environment is a serious social problem, since in most cases the urbanized territorial environment has a negative impact on people, which leads to a deterioration in their mental well-being. The most dangerous are aggressive and homogeneous visual fields, most often found in modern cities and towns. They also distinguish a comfortable visual environment, which contains a wide variety of visible elements, and a normal one, characterized by the occurrence of both homogeneous and aggressive visual fields that affect the state of the visual environment to a small extent.

The impact of various visual fields is based on the physiology of the human eye - the most active human sense organ, which is constantly in the process of analyzing the

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surrounding space and searching for reference points. Eye movements are called saccades, and their high frequency is an indication of the danger of the visual environment.

Aggressive visual fields are surfaces with a large number of identical elements evenly distributed on the plane. Such surfaces include, as a rule, the facades of modern multi-storey buildings. In an urban environment with aggressive facades of buildings, a person's eyes often perform saccades and cannot fix their gaze on a particular object, since after each saccade the eyes meet the same elements, as a result of which the same information is repeatedly sent to the brain, which can lead to stress. People who are regularly exposed to an aggressive visual environment are under constant stress, which, according to the studies of A. Wilkins, can cause paroxysmal disorders of consciousness, such as epilepsy and migraine attacks [2].

Homogeneous visual fields, on the contrary, are distinguished by the absence of visible elements that the human eye can catch on. These fields again include mainly the facades of the ends of multi-storey buildings, most often of the Soviet type, consisting of large-sized panels, as well as buildings with large glass facades.

If a homogeneous façade is in the field of view of a person and its viewing angle exceeds 15°, which is the maximum amplitude for 86% of saccades, the eyes may be in search of reference points on a homogeneous plane for several seconds, which inevitably leads to a feeling of discomfort. At the moment, often to reduce the homogeneity of the visual environment in cities, wall paintings or mosaics are used that hide homogeneous facades.

According to V. A. Filin, 1.5 - 2 times more people suffer from myopia in an urban environment than among residents of rural areas, in which the visual environment is more natural and does not abound in aggressive and homogeneous fields. This may be due not so much to the impact of the harmful visual fields themselves, but to insufficient training of the organs of vision during life in an urban environment, due to the lack of visual objects that are aesthetically attractive to humans, to which people would pay their attention on the streets.

2 Materials and methods

The aggressiveness of the visual environment is determined by the method of S.I. Fedosova, which allows you to evaluate the aggressiveness of any landscape by its photographic image. According to the methodology, it is necessary to overlay the grid on the photographic image of the area under study and calculate the aggressiveness coefficient (K_{agr}), which is equal to the ratio of grid cells with two or more identical visible elements ($H_п$) to the total number of all grid cells ($\sum_H$). The number of cells of the superimposed grid horizontally ($N_г$) and vertically ($N_в$) is calculated by the following formulas:

$$N_г = \frac{\alpha}{\varphi} \quad (1)$$

$$N_в = \frac{\beta}{\varphi} \quad (2)$$

Where α is the viewing angle of the area visible in the photo image horizontally, in degrees; β is the vertical viewing angle of the photographed area, in degrees; φ - the value of the angular size of the area of clear vision, in degrees (according to V. A. Filin - a constant value equal to 2 °).

The viewing angles of the vertical planes α and β are calculated as follows:

$$\alpha = arccos\frac{c_1^2 + c_2^2 - L_\Phi^2}{2 * c_1 + c_2} \quad (3)$$

$$\beta = arccos\frac{d^2 + L^2 - H * d}{\sqrt{(d^2 + L^2) * [(H - d)^2 + L^2]}} \quad (4)$$

Where c_1 and c_2 are the distances from the location of the photographer to the extreme boundaries of the area visible on the photographic image, m; L_f is the length of the visible area, m; d is the difference in the heights of the horizon level (human eye level) and the earth's surface within the area visible in the photographic image, m (on average, for territories where the relief is poorly expressed, it is taken equal to the distance to eye level); L is the horizontal distance from the viewpoint to the vertical passing through the middle of the line connecting the extreme boundaries of the photographed area, determined from cartographic materials, m; H is the height of the tallest object within the photographed area, m.

The aggressiveness coefficient (K_{agr}) is calculated by the formula:

$$K_{agr} = \frac{H_\text{п}}{\sum \text{H}} \quad (5)$$

The value of the aggressiveness coefficient varies from 0 to 1. The closer the K_{agr} value is to 1, the more aggressive the visual environment is, and if the value of the coefficient approaches zero, then, accordingly, the visual environment is non-aggressive.

3 Results

The study of the visual environment in terms of levels of aggressiveness and homogeneity was carried out in the northern part of the village of Maryanskaya, Krasnodar Territory, on Severnaya and Shevchenko streets along the route of the most intensive pedestrian traffic. In the study area of the village of Maryanskaya, the development is represented to a greater extent by one-story individual residential buildings and partly by buildings for communal, warehouse and commercial purposes.

Photographs were taken at five specific points in the study area to overlay a grid on them and determine the aggressiveness coefficient. The initial data for calculating the aggressiveness coefficient from 5 photographs, obtained using cartographic materials and by field measurements, are presented in Table 1.

Table 1. Initial data for calculating the aggressiveness coefficient.

Photo no.	Indicators					
	c_1	c_2	L_ϕ, m	L, m	H, m	d, m
1	26	24	30	20	10	1.75
2	10	8	11	7.5	10	1.75
3	35	45	54	30	10	1.75
4	30	40	43	28	10	1.75
5	30	80	78	47	10	1.75

Further, according to formulas 3 and 4 for each of the five photographs, the viewing angles horizontally (α) and vertically (β) were calculated:

$$\alpha_1 = arccos\frac{26^2+24^2-30^2}{2*26*24} = 73.6°;\ \beta_1 = arccos\frac{1.75^2+20^2-10*1.75}{\sqrt{(1.75^2+20^2)*[(10-1.75^2)+20^2]}} = 17.4°;$$

$$\alpha_2 = arccos\frac{10^2+8^2-11^2}{2*10*9} = 74.4°;\ \beta_2 = arccos\frac{1{,}75^2+7.5^2-10*1.75}{\sqrt{(1.75^2+7.5^2)*[(10-1.75^2)+7.5^2]}} = 46.9°;$$

$$\alpha_3 = arccos\frac{35^2+45^2-54^2}{2*35*45} = 83.9°;\ \beta_3 = arccos\frac{1.75^2+30^2-10*1.75}{\sqrt{(1.75^2+30^2)*[(10-1.75^2)+30^2]}} = 11.8°;$$

$$\alpha_4 = arccos\frac{30^2+40^2-43^2}{2*30*40} = 74.2°;\ \beta_4 = arccos\frac{1.75^2+28^2-10*1.75}{\sqrt{(1.75^2+28^2)*[(10-1.75^2)+28^2]}} = 12.7°;$$

$$\alpha_5 = arccos\frac{30^2+80^2-78^2}{2*30*80} = 75.3°;\ \beta_5 = arccos\frac{1.75^2+47^2-10*1.75}{\sqrt{(1.75^2+47^2)*[(10-1.75^2)+47^2]}} = 7.7°.$$

Then, according to formulas 1 and 2, the number of cells of the superimposed grid horizontally and vertically and the total number of cells were found. The data obtained in Table 2.

Table 2. Number of grid cells.

Photo no.	**Indicators**		
	$\mathbf{N_г}$	$\mathbf{N_в}$	$\mathbf{\sum H}$
1	36.8	8.7	320
2	37.2	23.4	872
3	41.9	5.9	247.5
4	37.1	6.35	235.6
5	37.6	3.85	144.9

In accordance with the calculated data, grids were superimposed on the photographs using the GIMP graphics editor. The result of the grid overlay on the example of one photograph is shown in Figures 1 and 2.

Fig. 1. Original photo.

Fig. 2. Grid photography.

After that, for each photographic image, the number of grid cells with two or more identical elements was determined: $H_{п1} = 55$; $H_{п2} = 0$; $H_{p3} = 48$; $H_{p4} = 40$; $H_{p5} = 15$. As a result, the coefficient of aggressiveness of the visual environment at five selected viewpoints was: $K_{agr1} = 0.17$; $K_{agr2} = 0$; $K_{agr3} = 0.19$; $K_{agr4} = 0.17$; $K_{agr5} = 0.1$.

Thus, the average index of the aggressiveness of the visual environment in the village of Maryanskaya along the streets of Severnaya and Shevchenko was 0.126, therefore, the visual environment is not aggressive.

Homogeneous visual fields were not found on the studied route along Severnaya and Shevchenko streets

4 Discussion

At the present stage of development, there is a need to solve problems to improve the quality of life of people under the condition of changing environmental conditions. In this regard, new ways appear, one of which is the aggressiveness and homogeneity of the visual environment in cities and towns. In this work, these components of the visual environment in the Severny microdistrict of the village of Maryanskaya were studied, the coefficient of aggressiveness was calculated, as a result of which it was found that the visual environment in the study area is comfortable for the population. This allows us to assert more comfortable conditions for the visual environment in rural areas, in contrast to urban areas.

5 Conclusion

Based on the results of the study, it can be concluded that the visual environment in the study area in the village of Maryanskaya is comfortable, which is due to the low number of storeys of buildings, the variety of house facades and the abundance of green spaces on the streets. It should be noted that these conditions of the visual environment are generally typical for most settlements in rural areas, in contrast to large cities, especially industrial ones, where the problems of aggressiveness and homogeneity of the visual environment are most acute.

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